Continuous Hot Water Recirc Pumps

The Biggest Energy Hog in Single Family Homes?

Presentation to the CEC by Steve Schmidt

High Energy Audits, Inc.

August 31, 2011

Agenda

- Who am I?
- What are they?
  (Continuous Hot Water Recirc Pumps)
- Where and How Many?
- Energy Use Analysis
- Mitigation Options

About Steve Schmidt

- Career:
  - Mechanical Engineer (Stanford '83)
  - Business Degree (Stanford '92)
  - 25+ years in Software Industry
- I was a Climate Change **Denier** (prior to 2005)

- Climate Change **Believer** (2005 – present)
  - Spearheaded my town's GHG Inventory (as volunteer)
- Residential Energy Research (since 2002)
  - My home & friends' homes (as hobby)
  - Industry Research (hardware, software, social issues, trends)
  - Training (PEC Audit Training, HOBO loggers, eQuest, HERS)
  - Detailed "high energy" home audits using homegrown approach
- Architect of two EECBG Programs
  - New company: High Energy Audits, Inc.
  - Collaboration of 5 Bay Area towns & Acterra ("High Energy Homes")
  - "EnergyUpgrade Mountain View"

WHAT ARE THEY?

Continuous Hot Water Recirculation Pumps

Where and How Many?

- Most big (>3,000 sf) modern homes have them
  - Los Altos Hills Building Inspector:
    Continuous recirc pumps have been installed in 90% of the homes built in our town over the past 10 years.
  - Building inspector for Portola Valley concurred.
- Installed in many other homes too
  - Quite a few ~2,000 sf homes have them *(one since 1961!)*
  - A 1,400 sf home used for HERS training had one
  - Many homeowners don't know they have them
- Current Stock
  - More recirc pumps than pool pumps.
  - Guesstimate: **Over 700,000 installed.**
    - 7M single family homes in California *(source: web search)*
    - 11% over 3000sf; 7% between 2500-3000sf (*DOE Bldngs Databook)*
    - 75% of homes over 3000sf + 40% of homes between 2500-3000sf

ENERGY USE ANALYSIS

- Tested 7 Single Family Homes (November 2009):
  - Electricity: **650 kWh** ***(~$250/year at top tier rates)***
  - Demand: **0.075 kW**
  - Natural Gas: **200 therms** ***(~$250/year at top rates)***
- Total energy cost to homeowner of **~$500/year**

- Aggregate annual energy use in CA:
  - **455 GWh** and **140 Mtherms**
  - Combined electricity and natural gas: **4,102 GWh**

- Rough calibration --
  - Data from recent Multifamily study (low rise):
    - Electricity: 1,228 kWh
    - Demand: 0.139 kW
    - Natural Gas: 1,083 therms

Source: Report by Yanda Zhang, Heschong Mahone Group, Inc.

MF DHW Improvement

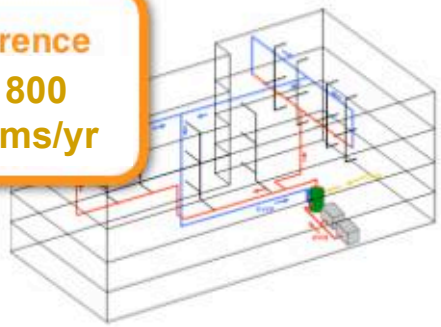
Data / Findings – Model Validation Results

Recirculation loop loss represents 34% of total hot water energy

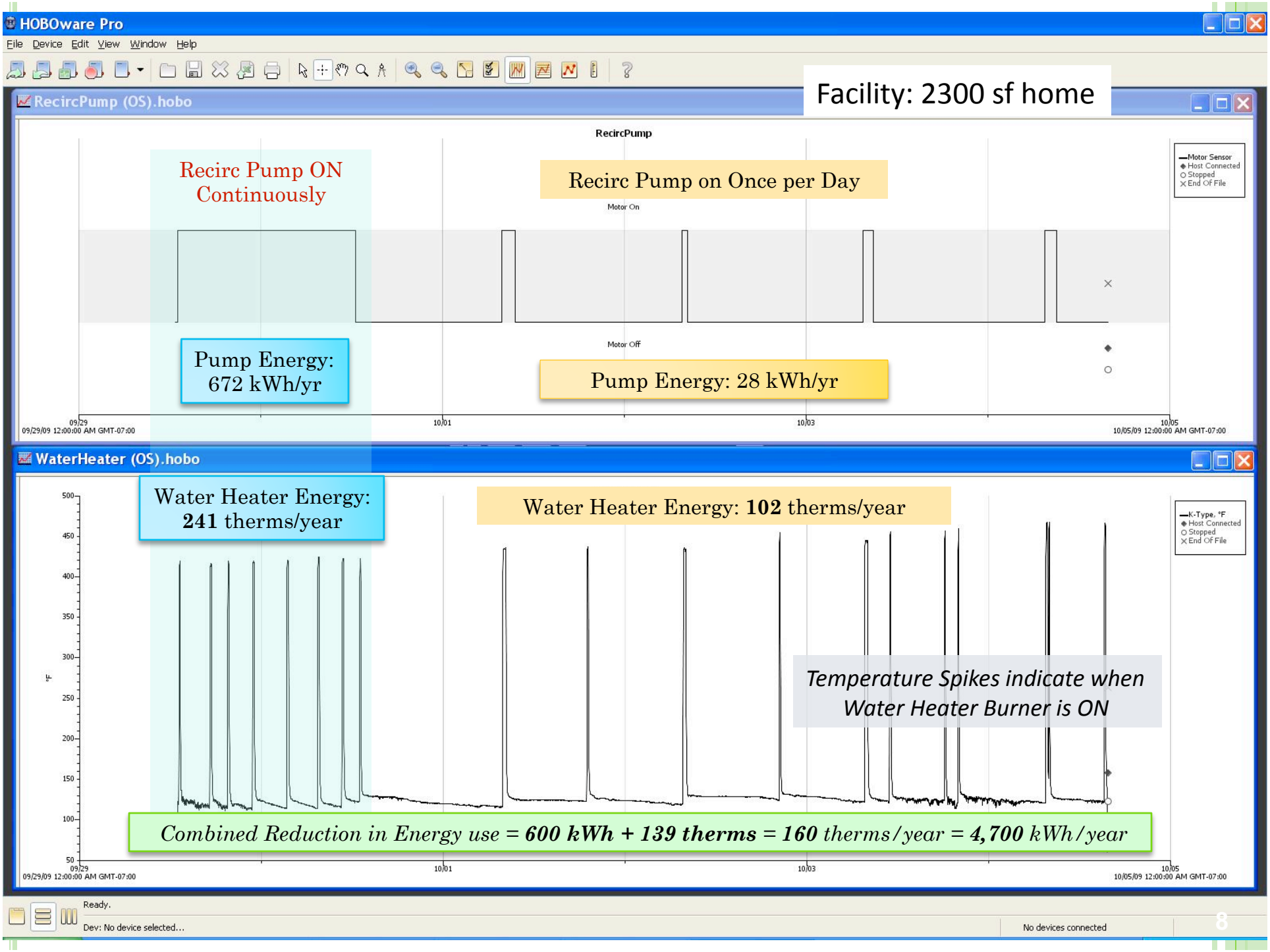
	Recirculation Flow Heat Loss				Recirculation Loop Heat Loss				Total Hot Water Energy			
SFD	Measured (Btu/day)	Modeled (Btu/day)	Measured reduction (%)	Modeled reduction (%)	Measured (Btu/day)	Modeled (Btu/day)	Measured reduction (%)	Modeled reduction (%)	Measured (Btu/day)	Modeled (Btu/day)	Measured reduction (%)	Modeled reduction (%)
CONT Pump	608,711	608,711	-	-	639,732	643,487	-	-	1,875,663	1,879,417	-	-
Temp Mod	600,697	582,695	1.3%	4.3%	635,433	616,266	1.0%	4.2%	1,958,764	1,941,597	-4.4%	-3.3%
Timer	507,048	461,656	17%	24%	600,803	52,822	6.1%	13%	1,732,428	1,694,446	7.6%	10%
Demand	215,483	191,328	65%	69%	411,903	4 556	36%	30%	1,423,628	1,465,281	24%	22%

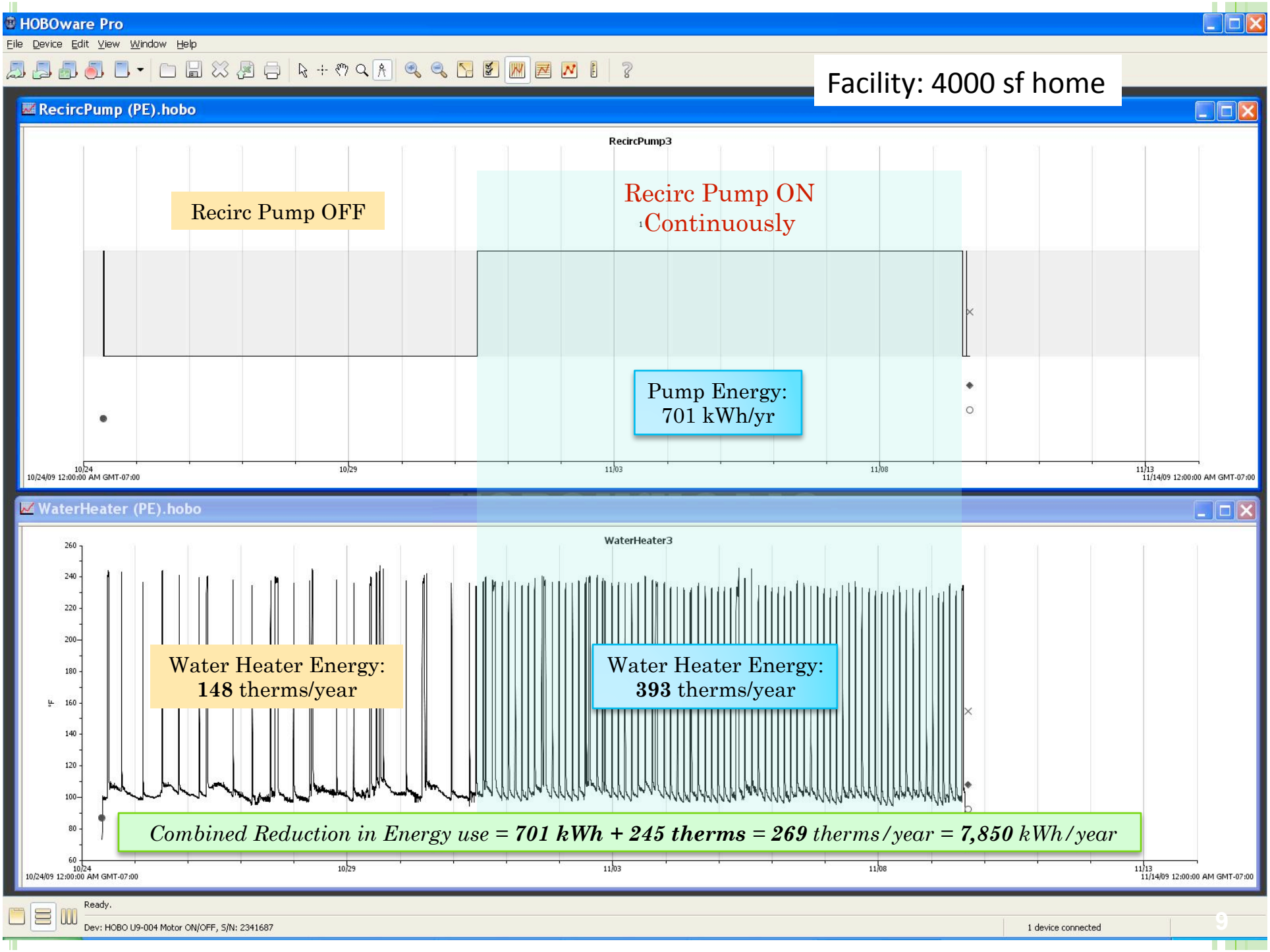
	w/o Flow Variation		HW Draw
SFD	Hot Water Energy (Btu/day)	Modeled savings (%)	Measured (Btu/day)
CONT Pump	1,879,417	-	1,235,931
Temp Mod	1,871,511	0.4%	1,325,331
Timer	1,816,132	3.4%	1,131,625
Demand	1,749,959	6.9%	1,011,725

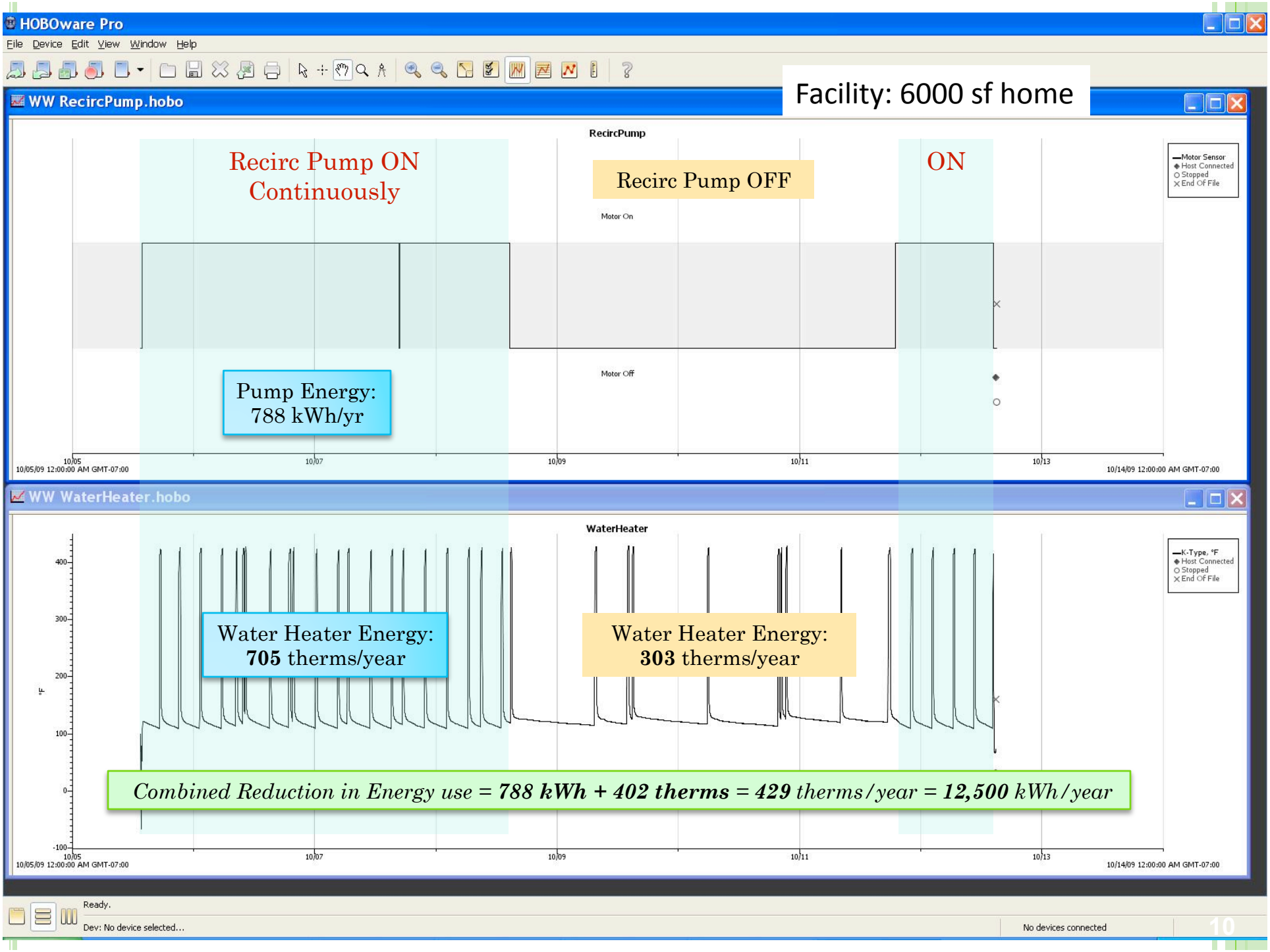
Difference of 800 therms/yr



Total hot water energy = Hot water draw + recirculation loop loss


HOBOware Pro
File Device Edit View Window Help
Facility: 2300 sf home
RecircPump (OS).hobo
RecircPump
Recirc Pump ON Continuously
Recirc Pump on Once per Day
Motor On
Motor Off
Motor Sensor
Host Connected
Stopped
End Of File
Pump Energy: 672 kWh/yr
Pump Energy: 28 kWh/yr
09/29
09/29/09 12:00:00 AM GMT-07:00
10/01
10/03
10/05
10/05/09 12:00:00 AM GMT-07:00
WaterHeater (OS).hobo
Water Heater Energy: 241 therms/year
Water Heater Energy: 102 therms/year
K-Type, °F
Host Connected
Stopped
End Of File
°F
500
450
400
350
300
250
200
150
100
50
Temperature Spikes indicate when Water Heater Burner is ON
Combined Reduction in Energy use = 600 kWh + 139 therms = 160 therms/year = 4,700 kWh/year
09/29/09 12:00:00 AM GMT-07:00
10/01
10/03
10/05/09 12:00:00 AM GMT-07:00
Ready.
Dev: No device selected...
No devices connected


HOBOware Pro
File Device Edit View Window Help
Facility: 4000 sf home
RecircPump (PE).hobo
RecircPump3
Recirc Pump OFF
Recirc Pump ON
Continuously
Pump Energy:
701 kWh/yr
10/24
10/29
11/03
11/08
11/13
10/24/09 12:00:00 AM GMT-07:00
11/14/09 12:00:00 AM GMT-07:00
WaterHeater (PE).hobo
WaterHeater3
°F
Water Heater Energy:
148 therms/year
Water Heater Energy:
393 therms/year
Combined Reduction in Energy use = 701 kWh + 245 therms = 269 therms/year = 7,850 kWh/year
Ready.
Dev: HOBO U9-004 Motor ON/OFF, S/N: 2341687
1 device connected


HOBOware Pro
File Device Edit View Window Help
WW RecircPump.hobo
Facility: 6000 sf home
RecircPump
Recirc Pump ON Continuously
Recirc Pump OFF
ON
Motor On
Motor Off
Motor Sensor
Host Connected
Stopped
End Of File
Pump Energy: 788 kWh/yr
10/05/09 12:00:00 AM GMT-07:00
10/14/09 12:00:00 AM GMT-07:00
WW WaterHeater.hobo
WaterHeater
K-Type, °F
Water Heater Energy: 705 therms/year
Water Heater Energy: 303 therms/year
Combined Reduction in Energy use = 788 kWh + 402 therms = 429 therms/year = 12,500 kWh/year
Ready.
Dev: No device selected...
No devices connected

Mitigation Options

- For New Construction *(**Not** my focus)*
  - Ban them? Require timers or demand?
  - Same as multifamily.
- For Existing Single Family Residences
  1. Unplug it for a week
  2. Add a cheap digital timer ($25)
  3. Replace or upgrade with “on-demand” model ($200)

Bonus: Often can be Identified via Utility Bill Disaggregation

Likely!